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(54) METHOD AND SYSTEM FOR POWER-CONSERVING INTERFERENCE AVOIDANCE IN COMMUNICATION BETWEEN A MOBILE UNIT AND A BASE UNIT IN A WIRELESS TELECOMMUNICATION SYSTEM

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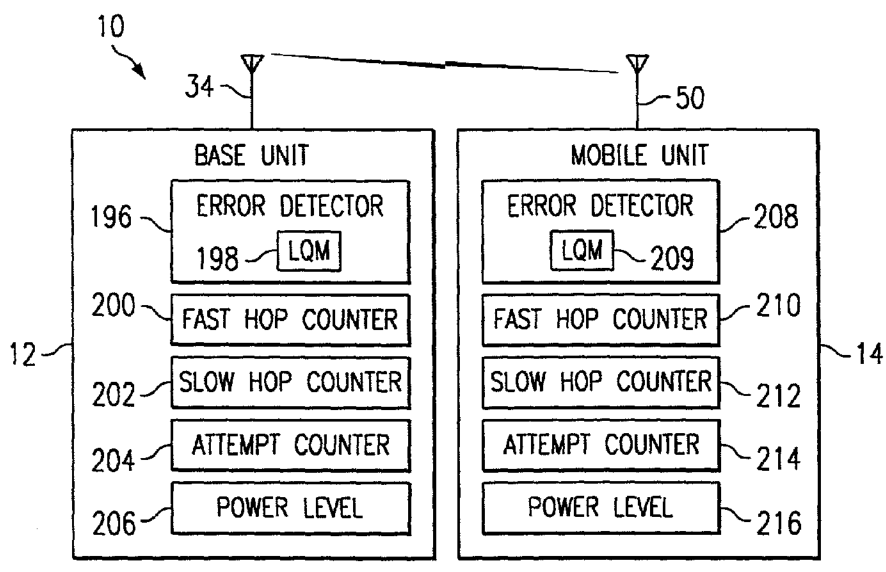
(57) **ABSTRACT**

A method for avoiding interference in a wireless telecommunication system is provided. The method includes providing communication between a first and second component at an initial frequency. A plurality of successive line quality indicators is determined at a line quality monitor of the first component. Consecutive line quality indicators are summed over a predetermined time to determine a slow hop count. A determination is made as to whether the slow hop count is greater than a slow hop threshold. A determination is made as to whether to provide communication with the first component at a second frequency when the slow hop count is greater than the slow hop threshold. This determination is based on a power level of the second component and a communication strength received from the second component at the first component. A signal is communicated from the first component to the second component requesting the second component to provide communication at the second frequency.



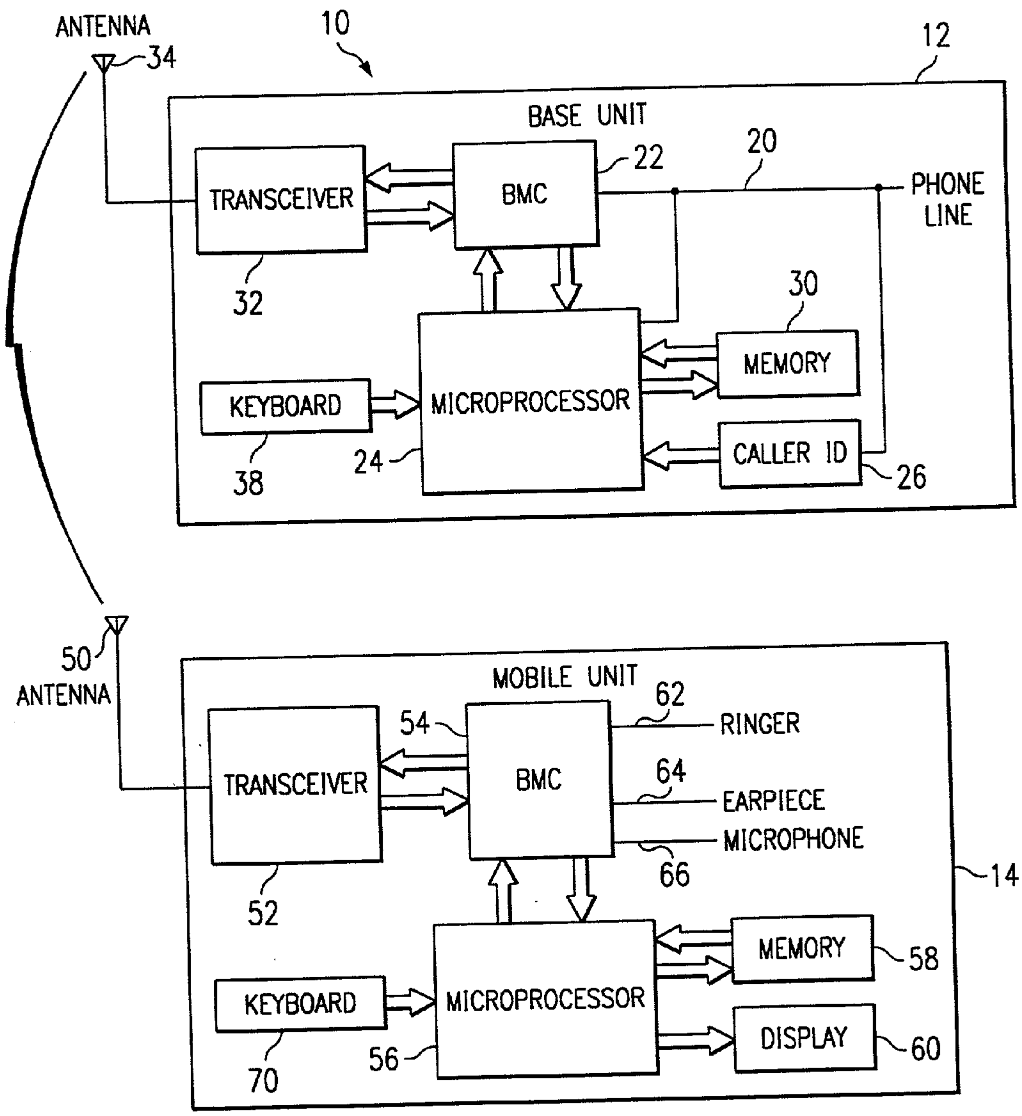

ANTENNA
34
10
12
BASE UNIT
TRANSCEIVER
BMC
22
20
PHONE LINE
32
30
MEMORY
KEYBOARD
MICROPROCESSOR
CALLER ID
38
24
26
50
ANTENNA
MOBILE UNIT
62
RINGER
54
TRANSCEIVER
BMC
64
EARPIECE
MICROPHONE
66
14
52
MEMORY
58
KEYBOARD
MICROPROCESSOR
DISPLAY
60
70
56

FIG. 1

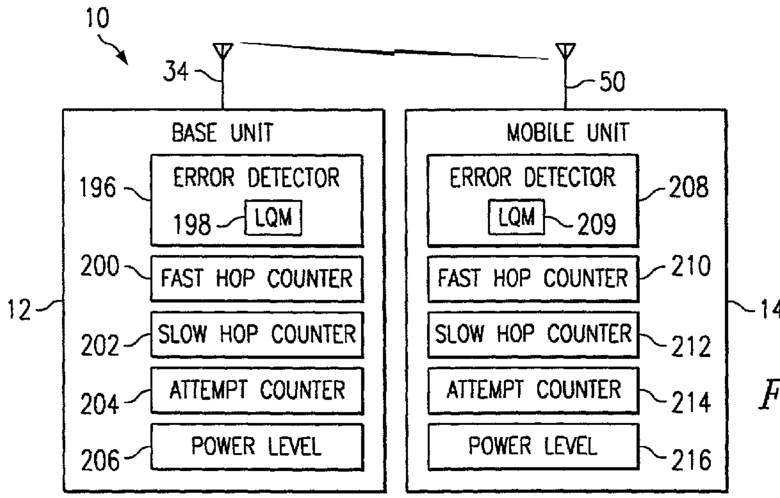

10
34
50
BASE UNIT
MOBILE UNIT
ERROR DETECTOR
LQM
196
198
200
202
204
206
FAST HOP COUNTER
SLOW HOP COUNTER
ATTEMPT COUNTER
POWER LEVEL
12
ERROR DETECTOR
LQM
208
209
210
212
214
216
FAST HOP COUNTER
SLOW HOP COUNTER
ATTEMPT COUNTER
POWER LEVEL
14

FIG. 2

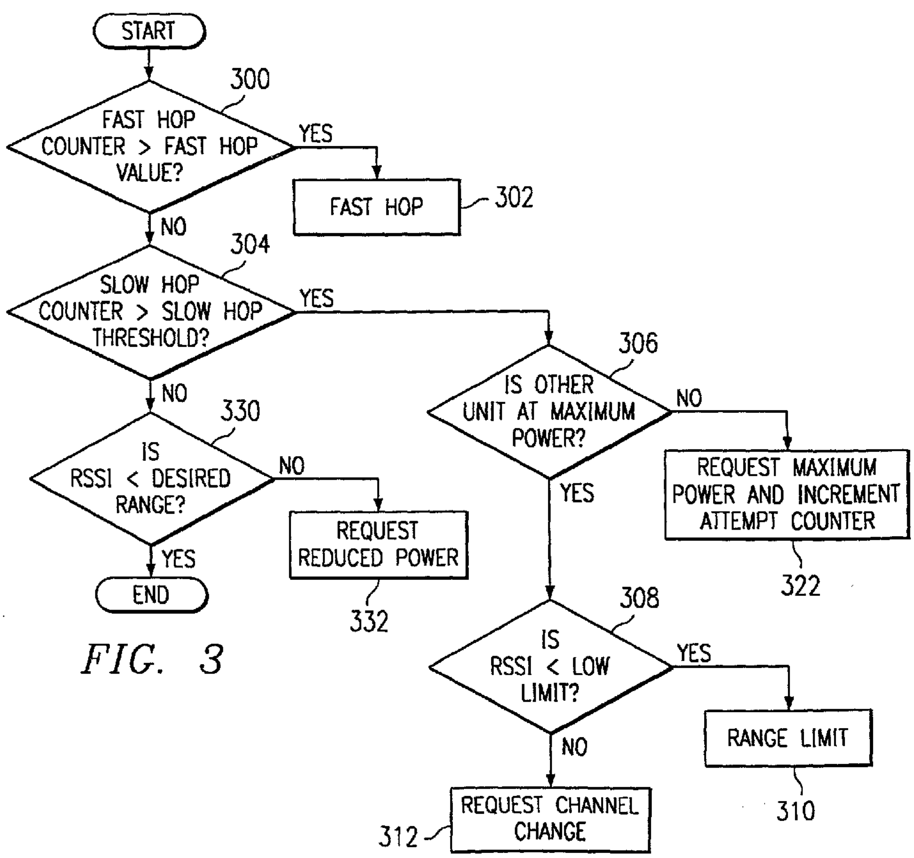

START
300
FAST HOP COUNTER > FAST HOP VALUE?
YES
FAST HOP
302
NO
304
SLOW HOP COUNTER > SLOW HOP THRESHOLD?
YES
306
IS OTHER UNIT AT MAXIMUM POWER?
NO
REQUEST MAXIMUM POWER AND INCREMENT ATTEMPT COUNTER
322
YES
308
IS RSSI < LOW LIMIT?
YES
RANGE LIMIT
310
NO
REQUEST CHANNEL CHANGE
312
NO
330
IS RSSI < DESIRED RANGE?
NO
REQUEST REDUCED POWER
332
YES
END

FIG. 3

METHOD AND SYSTEM FOR POWER-CONSERVING INTERFERENCE AVOIDANCE IN COMMUNICATION BETWEEN A MOBILE UNIT AND A BASE UNIT IN A WIRELESS TELECOMMUNICATION SYSTEM

TECHNICAL FIELD OF THE INVENTION

[0001] This invention relates generally to the field of telecommunications and, more specifically, to a method and system for power-conserving interference avoidance in communication between a mobile unit and a base unit in a wireless telecommunication system.

BACKGROUND OF THE INVENTION

[0002] As society grows more complex and operates at an ever accelerating pace, there has been a growing need for better and more flexible communication devices. One area that has experienced substantial development activity is the area of wireless communication. Wireless telephone systems are also known as portable, cordless or mobile telephone systems. A typical wireless communication system has a base station located at a customer's or user's premises. The base is connected to the Public Switched Telephone Network (PSTN) over a wireline interface and communicates with a mobile unit or handset over an air interface that permits the user to communicate remotely from the base station. While users desire the freedom and flexibility afforded by mobile wireless communications systems, they typically do not want to sacrifice the numerous features, such as caller ID, that are available through the wireline service over the PSTN. In addition, users of wireless systems increasingly demand a voice quality that is as good as the voice quality available over a wireline link.

[0003] In the past, the enhanced features and high voice quality demanded by users have been achieved by the use of sophisticated and complex algorithms and methods that require substantial processor resources and large amounts of memory. These processing and memory resources are not only expensive but also place a substantial drain on battery power, therefore shortening the effective use of the mobile unit. Other technical problems associated with the need for using faster and more powerful processors include larger packaging to accommodate the larger-sized components and to dissipate the heat generated by such units. In the past, wireless systems have been large and bulky and have weighed more than what is satisfactory to many users.

[0004] While wireless communication devices and methods have provided an improvement over prior approaches in terms of features, voice quality, cost, packaging size and weight, the challenges in the field of wireless telecommunications have continued to increase with demands for more and better techniques having greater flexibility and adaptability.

[0005] Therefore, a need has arisen for a new method and system for power-conserving interference avoidance in communication between a base unit and a mobile unit in a wireless telecommunication system.

SUMMARY OF THE INVENTION

[0006] In accordance with the present invention, a method and system for power-conserving interference avoidance in communication between a mobile unit and a base unit in a wireless telecommunication system are provided that substantially eliminate or reduce disadvantages and problems associated with previously developed systems and methods.

[0007] A method for avoiding interference in a wireless telecommunication system is disclosed. The method includes providing communication between a first and second component at an initial frequency. A plurality of successive line quality indicators is determined at a line quality monitor of the first component. Consecutive line quality indicators are summed over a predetermined time to determine a slow hop count. A determination is made as to whether the slow hop count is greater than a slow hop threshold. A determination is made as to whether to provide communication with the first component at a second frequency when the slow hop count is greater than the slow hop threshold. This determination is based on a power level of the second component and a communication strength received from the second component at the first component. A signal is communicated from the first component to the second component requesting the second component to provide communication at the second frequency.

[0008] Technical advantages of the present invention include providing for power-conserving interference avoidance in communication between a mobile unit and a base unit in a telecommunication system. In particular, a slow hop count for a first component includes a summation of consecutive line quality indicators. A determination is made as to whether to change communication frequencies for the first component when the slow hop count is greater than a slow hop threshold. This determination is based on a power level of a second component and a communication strength received from the second component at the first component. Accordingly, a change in communication frequencies is made after evaluating whether interference is causing the poor line quality indicated by the slow hop count, as opposed to other factors such as low power for signal transmission. As a result, interference is avoided while power is conserved by providing for transmitting at lower power levels as long as good quality signals are being received.

[0009] Other technical advantages of the present invention will be readily apparent to one skilled in the art from the following figures, descriptions and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] For a more complete understanding of the present invention, the objects and advantages thereof, reference is now made to the following descriptions taken in connection with the accompanying drawings in which:

[0011] **FIG. 1** is a block diagram illustrating a wireless telecommunication system including a base unit and a mobile unit constructed in accordance with the teachings of the present invention;

[0012] **FIG. 2** is a block diagram illustrating a system for avoiding interference in wireless communication between the base unit and the mobile unit of **FIG. 1** while conserving power in accordance with one embodiment of the present invention; and

[0013] **FIG. 3** is a flow diagram demonstrating one method for avoiding interference in wireless communication between the base unit and the mobile unit of **FIG. 1** while conserving power.

DETAILED DESCRIPTION OF THE DRAWINGS

[0014] The preferred embodiment of the present invention and its advantages are best understood by referring to **FIGS. 1 through 3** of the drawings, like numerals being used for like and corresponding parts of the various drawings.

[0015] **FIG. 1** is a block diagram illustrating a telecommunication system **10** including a base unit **12** and a mobile unit **14**. The base unit **12** and the mobile unit **14** communicate with each other at a frequency in the industrial/scientific/medical (ISM) band. For example, the units **12** and **14** may communicate in the range of 2400 to 2483.5 MHz. It will be understood, however, that the base unit **12** and the mobile unit **14** may communicate with each other at other suitable frequencies without departing from the scope of the present invention.

[0016] The telecommunication system **10** illustrated in **FIG. 1** is a wireless or cordless telephone system. In this exemplary embodiment, the mobile unit **14** comprises a mobile handset that communicates with the base unit **12** over discreet radio frequency channels. Although the telecommunication system **10** is illustrated as a cordless telephone system, it will be understood that the telecommunication system **10** may comprise any suitable type of wireless communication system. For example, the telecommunication system **10** may comprise a cellular telephone system, Local Multiple Distribution Service, and the like, without departing from the scope of the present invention.

[0017] In accordance with the exemplary embodiment shown in **FIG. 1**, the base unit **12** comprises a phone line **20** that is coupled to the Public Switched Telephone Network over a landline for receiving and transmitting voice or other data. For an incoming telephone call, data from the phone line **20** is passed to a microprocessor **24** and a caller ID interface **26**. The caller ID interface **26** extracts caller ID information, such as a name and a telephone number associated with the originator of the telephone call, from the data on the phone line **20** and passes it to the microprocessor **24**. The microprocessor **24** communicates with an internal memory **30** while processing the data received from the phone line **20** and the caller ID interface **26**.

[0018] The microprocessor **24** then communicates the processed data from the phone line **20** and the caller ID interface **26**, along with any additional data that needs to be transmitted to the mobile unit **14**, to a burst mode controller (BMC) **22**. The BMC **22** also receives data directly from the phone line **20**, which is processed along with the data from the microprocessor **24**. For example, the BMC **22** packages voice data from the phone line **20** with additional data from the microprocessor **24** into one frame structure. The BMC **22** also communicates the data to a transceiver **32** which transmits a signal through an antenna **34** to the mobile unit **14**. The base unit **12** also comprises a keyboard **38** for inputting data to the microprocessor **24**. The keyboard **38** may comprise a numeric keypad for entering a telephone number or other data. The keyboard **38** may also comprise a pager button for paging the mobile unit **14** such that the mobile unit **14** provides a sound for locating the mobile unit **14**.

[0019] The mobile unit **14** receives the signal from the base unit **12** through an antenna **50** which passes the data to a transceiver **52**. The transceiver **52** processes the data and it to a BMC **54**, which unpackages the data and communicates with a microprocessor **56**. The microprocessor **56** communicates with an internal memory **58** and sends data to a display **60**, such as an LCD or LED. For example, the microprocessor **56** may send to the display **60** a name and a telephone number extracted by the caller ID interface **26** in the base unit **12**.

[0020] The BMC **54** also sends a signal to a ringer **62** to notify a user of an incoming call. After the user responds by activating the mobile unit **14**, the BMC **54** sends the voice data received from the base unit **12** to an earpiece **64**. After the connection is completed, voice data for transmission to the phone line **20** through the base unit **12** is received by the BMC **54** from the microphone **66**. This data is transmitted from the mobile unit **14** to the base unit **12** in a similar manner to the transmission of data from the phone line **20** to the earpiece **64**. The mobile unit **14** also comprises a keyboard **70** for a user to enter information for communication to the microprocessor **56**. This keyboard **70** may be, for example, a numeric keypad on a mobile telephone handset for entering a telephone number.

[0021] The same process is also used for an outgoing telephone call, beginning with the activation of the mobile unit **14**, which sends a signal through the BMC **54** to the transceiver **52** and from the transceiver **52** to the antenna **50**. From the antenna **50** of the mobile unit **14** the signal is transmitted to the antenna **34** of the base unit **12**, which passes the signal to the transceiver **32**. The transceiver **32** passes the signal through the BMC **22** to the phone line **20**. The telephone number being called, voice and other data is then communicated back and forth between the mobile unit **14** and the base unit **12** as previously described.

[0022] **FIG. 2** is a block diagram illustrating one embodiment of the telecommunication system **10** of **FIG. 1**, including a system for avoiding interference in wireless communication between the base unit **12** and the mobile unit **14** while conserving power. The base unit **12** comprises an error detector **196** for detecting errors in communication between the base unit **12** and the mobile unit **14**. The error detector **196** includes a line quality monitor **198** for determining the quality of the signal being received at the base unit **12** from the mobile unit **14**. The base unit **12** also comprises a fast hop counter **200** and a slow hop counter **202** for determining when and how the base unit **12** will change the frequency of communication due to a poor quality signal.

[0023] As described in more detail below, the base unit **12** changes frequencies quickly when catastrophic interference greatly reduces the signal quality. This is called a fast hop. However, if the signal quality is poor, but not poor enough for a fast hop, the base unit **12** determines whether to change frequencies after evaluating other factors. This is called a slow hop. The base unit **12** comprises an attempt counter **204** and a power level field **206** that are used in conjunction with the slow hop counter **202** by the base unit **12** to evaluate the other factors in order to determine whether or not to complete a slow hop.

[0024] Similarly to the base unit **12**, the mobile unit **14** comprises an error detector **208** for detecting errors in communication between the base unit **12** and the mobile unit **14**. The error detector **208** includes a line quality monitor **209** for determining the quality of the signal being received at the mobile unit **14** from the base unit **12**. The mobile unit

14 also comprises a fast hop counter **210** and a slow hop counter **212** for determining when and how the mobile unit **14** will change the frequency of communication due to a poor quality signal.

[**0025**] As with the base unit **12** and as described in more detail below, the mobile unit **14** performs a fast hop when catastrophic interference greatly reduces the signal quality. However, if the signal quality is poor, but not poor enough for a fast hop, the mobile unit **14** determines whether to perform a slow hop after evaluating other factors. The mobile unit **14** comprises an attempt counter **214** and a power level field **216** that are used in conjunction with the slow hop counter **212** by the mobile unit **14** to evaluate the other factors in order to determine whether or not to complete a slow hop.

[**0026**] For both the base unit **12** and the mobile unit **14**, the line quality monitors **198** and **209** determine a plurality of successive line quality indicators at regular intervals. Each line quality indicator comprises a value associated with the quality of the received signal. According to the disclosed embodiment, a higher value for a line quality indicator corresponds to a lower quality signal.

[**0027**] The values for all the counters **200**, **202**, **210** and **212** are based on the line quality indicators from the line quality monitor **198**. The fast hop counters **200** and **210** are used to determine whether catastrophic interference is affecting the signal such that the corresponding unit **12** or **14** should change communication frequencies relatively quickly. Each fast hop counter **200** and **210** is incremented or cleared with each successive line quality indicator from the corresponding line quality monitor **198** or **209**. Thus, for each line quality indicator over a fast hop threshold, the corresponding fast hop counter **200** or **210** is incremented. However, if a line quality indicator is not greater than the fast hop threshold, the corresponding fast hop counter **200** or **210** is cleared. If the fast hop counter **200** reaches a pre-determined value, indicating that an equivalent number of consecutive line quality indicators were greater than the fast hop threshold, the corresponding unit **12** or **14** performs a fast hop.

[**0028**] The slow hop counters **202** and **212** are used to determine whether interference that is not catastrophic is nevertheless sufficient to prompt the corresponding unit **12** or **14** to change communication frequencies. The slow hop counters **202** and **212** include a continuing summation of consecutive line quality indicators from the corresponding line quality monitors **198** and **209** over a pre-determined amount of time. If a slow hop counter **202** or **212** reaches a value greater than a slow hop threshold, the corresponding unit **12** or **14** initiates a slow hop determination procedure, as described below. However, if after the pre-determined amount of time the slow hop counters **202** and **212** have not reached the slow hop threshold, the slow hop counters **202** and **212** are cleared to a value of zero before including a continuing summation of additional consecutive line quality indicators from the line quality monitors **198** and **209**.

[**0029**] The slow hop determination procedure is initiated in order to determine whether or not to perform a slow hop if a slow hop counter **202** or **212** reaches the slow hop threshold during the pre-determined amount of time. This procedure includes a determination of whether the unit **14** or **12** other than the unit **12** or **14** with the slow hop counter **202** or **212** that has reached the slow hop threshold ("the other unit") is transmitting signals at a maximum power level. According to one embodiment, both the base unit **12** and the mobile unit **14** may operate at four different power levels, as indicated by the power level fields **206** and **216**. It will be understood, however, that the units **12** and **14** may operate at any suitable number of power levels without departing from the scope of the present invention. Thus, if a slow hop counter **202** or **212** reaches the slow hop threshold, the corresponding unit **12** or **14** requests the other unit **14** or **12** to transmit at a maximum power level.

[**0030**] When this request is made, the corresponding attempt counter **204** or **214** for the unit **12** or **14** making the request is incremented. If the same slow hop counter **202** or **212** again reaches the slow hop threshold, the corresponding unit **12** or **14** determines by the value of the attempt counter **204** or **214** that the other unit **14** or **12** is transmitting at maximum power.

[**0031**] The slow hop determination procedure also includes a determination by the unit **12** or **14** of whether a radio signal strength indicator (RSSI) is less than a lower limit for signal strength. If this is the case, the other unit **14** or **12** is outside of the range in which communication is possible. However, if the RSSI is not less than the lower limit, the unit **12** or **14** performs a slow hop by signaling the other unit **12** or **14** that a slow hop is being performed and providing communication at a subsequent frequency.

[**0032**] **FIG. 3** is a flow diagram demonstrating one method for avoiding interference in wireless communication between the base unit **12** and the mobile unit **14** of **FIG. 1** while conserving power. The method is preferably performed by both the base unit **12** and the mobile unit **14** simultaneously. The method begins at decisional step **300** where the fast hop counters **200** and **210** are compared to a fast hop value. If a fast hop counter **200** or **210** is greater than the fast hop value, the method follows the Yes branch from decisional step **300** to step **302** where the corresponding unit **12** or **14** performs a fast hop to a subsequent frequency. However, if the fast hop counters **200** or **210** are not greater than the fast hop value, the method follows the No branch from decisional step **300** to decisional step **304** where the slow hop counters **202** and **212** are compared to a slow hop threshold.

[**0033**] If a slow hop counter **202** or **212** is greater than the slow hop threshold, the method follows the Yes branch from decisional step **304** to decisional step **306** where the corresponding unit **12** or **14** determines whether the other unit **14** or **12** is transmitting at maximum power. According to one embodiment, this determination is made by evaluating the attempt counter **204** or **214** which indicates whether the unit **12** or **14** previously requested the other unit **14** or **12** to transmit at a maximum power level. If the other unit **14** or **12** is transmitting at maximum power, the method follows the Yes branch from decisional step **306** to decisional step **308** where the base unit **12** determines whether the RSSI is less than the lower limit. If the RSSI is less than the lower limit, the method follows the Yes branch from decisional step **308** to step **310** where the unit **12** or **14** determines that the other unit **14** or **12** is outside the range for communication.

[**0034**] Returning to decisional step **308**, if the RSSI is not less than the lower limit, the method follows the No branch to step **312** where the unit **12** or **14** performs a slow hop by changing to a subsequent frequency and requesting the other unit **14** or **12** to change to the subsequent frequency.

[**0035**] Returning to decisional step **306**, if the other unit **14** or **12** is not transmitting at maximum power, the method follows the No branch to step **322** where the unit **12** or **14** requests the other unit **14** or **12** to transmit at maximum power and increments the attempt counter **204** or **214**.

[**0036**] Returning to decisional step **304**, if the slow hop counters **202** and **212** are not greater than the slow hop threshold, the method follows the No branch to decisional step **330** where the unit **12** or **14** determines whether the RSSI is less than the desired range. If the RSSI is less than the desired range, the method follows the Yes branch from decisional step **330** and the method comes to an end. However, if the RSSI is not less than the desired range, the method follows the No branch from decisional step **330** to step **332** where the unit **12** or **14** requests the other unit **14** or **12** to reduce the transmission power as indicated in the power level field **216** or **206** to a lower power level.

[**0037**] While the invention has been particularly shown and described by the foregoing detailed description, it will be understood by those skilled in the art that various other changes in form and detail may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. A method for avoiding interference in a wireless telecommunication system, comprising:

providing communication between a first and second component at an initial frequency;

determining a plurality of successive line quality indicators at a line quality monitor of the first component;

summing consecutive line quality indicators over a predetermined time to determine a slow hop count;

determining whether the slow hop count is greater than a slow hop threshold;

determining whether to provide communication with the first component at a second frequency when the slow hop count is greater than the slow hop threshold, the determination based on a power level of the second component and a communication strength received from the second component at the first component; and

communicating a signal from the first component to the second component requesting the second component to provide communication at the second frequency.

2. The method of claim 1, the first component comprising a mobile unit and the second component comprising a base unit.

3. The method of claim 1, the first component comprising a base unit and the second component comprising a mobile unit.

4. The method of claim 1, further comprising providing communication with the first component at the second frequency when a specified number of consecutive line quality indicators is greater than a fast hop threshold.

5. The method of claim 4, the first component comprising a mobile unit and the second component comprising a base unit.

6. The method of claim 4, the first component comprising a base unit and the second component comprising a mobile unit.

7. A system for avoiding interference in a wireless telecommunication system, comprising:

a first component;

a second component for providing wireless communication with the first component at an initial frequency;

a line quality monitor for the first component, the line quality monitor for determining a plurality of successive line quality indicators;

a slow hop counter for summing consecutive line quality indicators over a predetermined time to determine a slow hop count and for determining whether the slow hop count is greater than a slow hop threshold;

an error detector for determining whether to provide communication with the first component at a second frequency when the slow hop count is greater than the slow hop threshold, the determination based on a power level of the second component and a communication strength received from the second component at the first component, and

the first component operable to communicate a signal to the second component requesting the second component to provide communication at the second frequency.

8. The system of claim 7, the first component comprising a mobile unit and the second component comprising a base unit.

9. The system of claim 7, the first component comprising a base unit and the second component comprising a mobile unit.

10. The system of claim 7, further comprising:

a fast hop counter for monitoring a number of consecutive line quality indicators greater than a fast hop threshold to determine a fast hop count; and

the error detector also for providing communication with the first component at the second frequency when the fast hop count is greater than a fast hop value.

11. The system of claim 10, the first component comprising a mobile unit and the second component comprising a base unit.

12. The system of claim 10, the first component comprising a base unit and the second component comprising a mobile unit.

13. A method for conserving power in a wireless communication system, comprising:

providing communication between a first and second component;

transmitting an initial signal from the first component to the second component at a first power level;

receiving the initial signal from the first component at the second component;

determining a communication strength for the initial signal at the second component; and

transmitting from the second component to the first component a request for the first component to transmit a subsequent signal at a second power level, the second power level based on the communication strength for the initial signal.

14. The method of claim 13, the communication strength greater than a desired range and the second power level less than the first power level.

15. The method of claim 13, the communication strength less than a desired limit and the second power level greater than the first power level.

16. The method of claim 13, the first component comprising a mobile unit and the second component comprising a base unit.

17. The method of claim 13, the first component comprising a base unit and the second component comprising a mobile unit.

* * * * *